



**US Army Corps
of Engineers**

Waterways Experiment
Station

Preliminary Data Summary for January 1995 CERC Field Research Facility

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Contents

Preface	iv
1 — Introduction	1
2 — Meteorological Data	7
3 — Wave Data	12
4 — Current Data	17
5 — Visual Observations	20
6 — Water Levels	22
7 — Bathymetry	24
8 — Special Events	27

List of Figures

<u>No.</u>		
1	FRF Location Map	2
2	Month at a Glance	3
3	Instrument Locations at FRF	6
4	Meteorological Monthly Summary	8
5	Wave Heights and Periods	16
6	Water Levels	22
7	CRAB Profiles	24
8	CRAB Profile Envelope	25
9	FRF Bathymetry (25 January 95)	26

List of Tables

<u>No.</u>		
1	Instrument Status/Data Availability	4
2	Gauge Locations	5
3	Meteorological Data	9
4	Wave Data	13
5	Current Meter Data	18
6	Visually Observed Current Data	19
7	Visual Observations	21
8	Water Levels	23

Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

1 Introduction

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

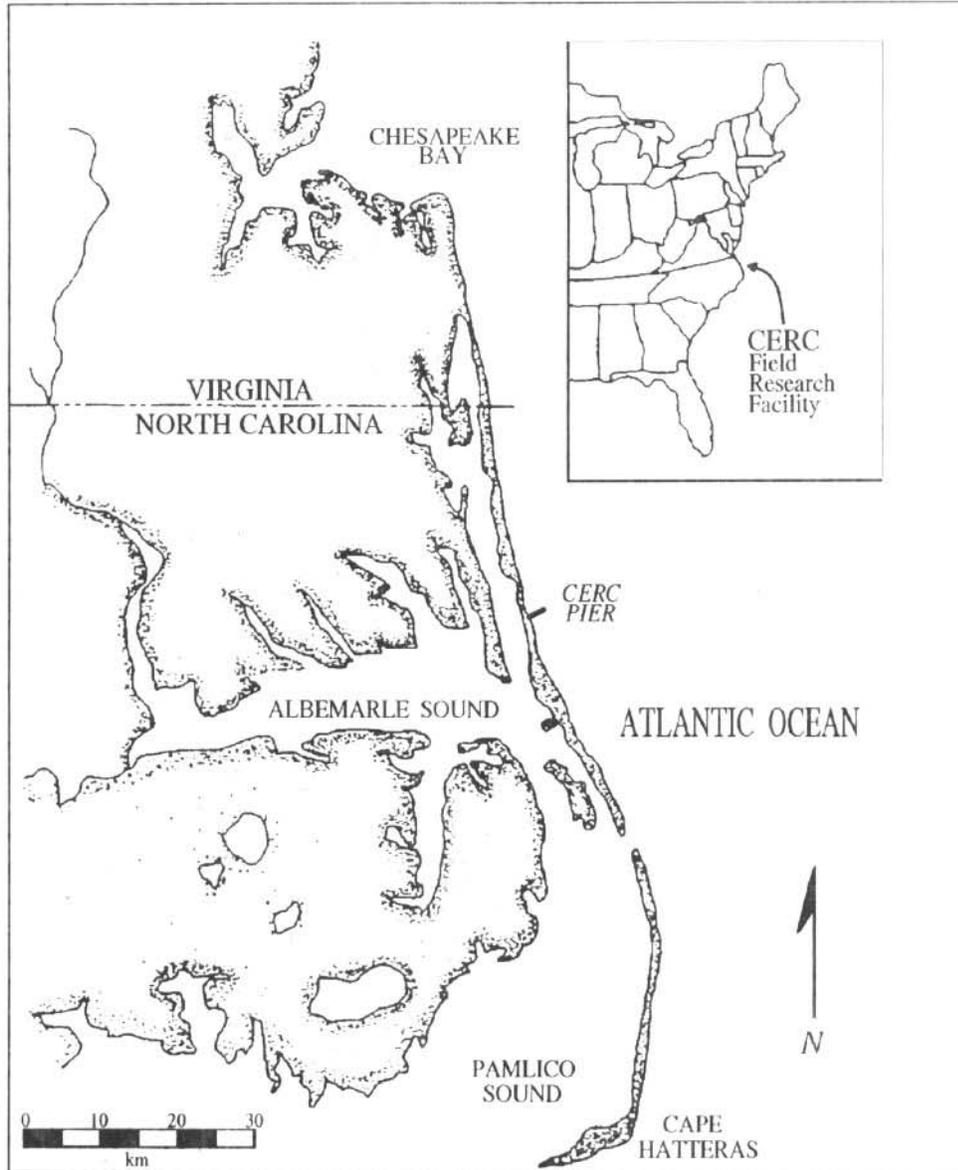


Figure 1. FRF Location Map

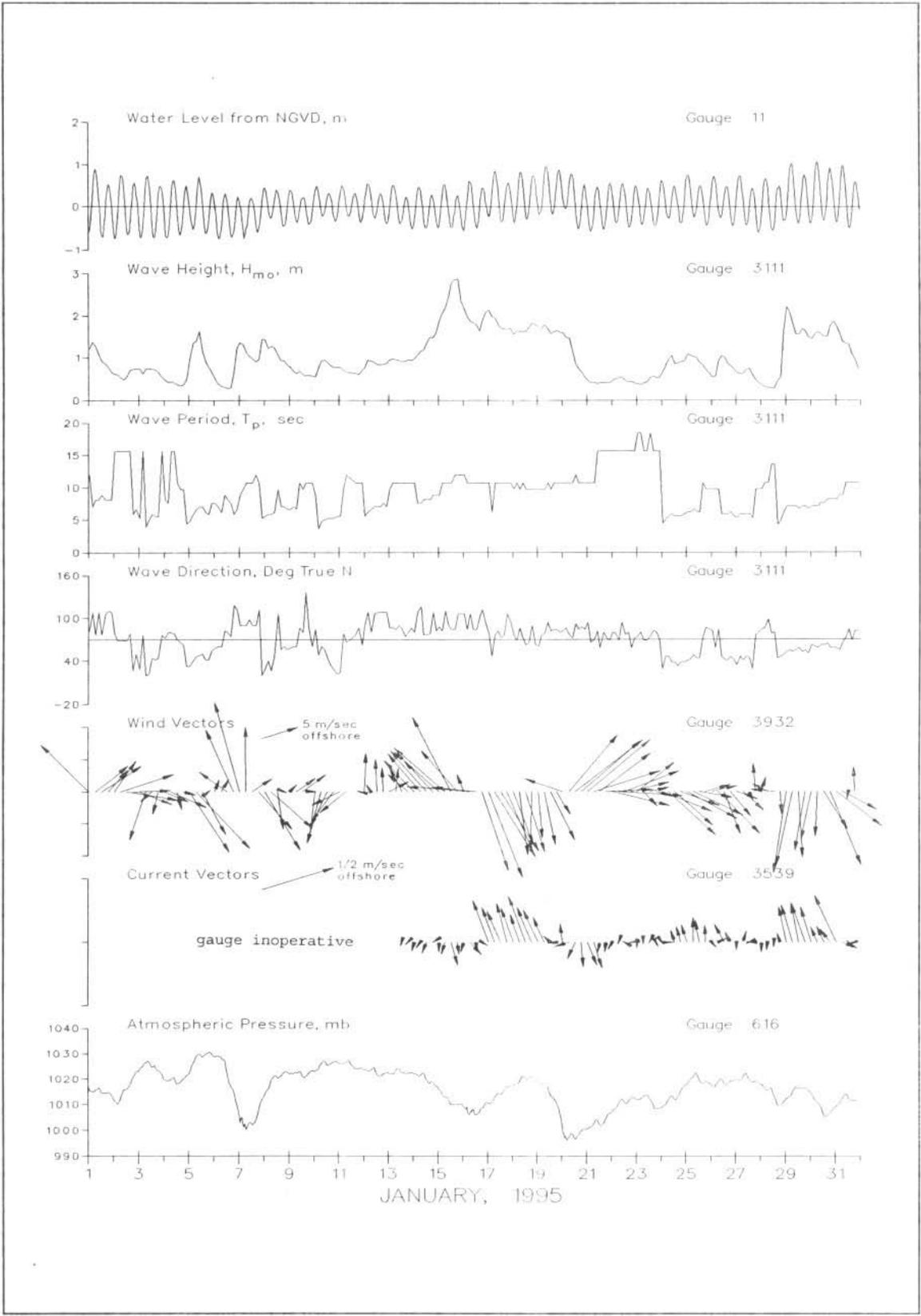


Figure 2. Month at a Glance

**Table 1
Instrument Status/Data Availability**

			January 1995																															
			Day of the month																															
Gauge ID	Description/Remarks		1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	2	2	2	2	2	2	2	3	3	
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	-	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	-	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Visual Observations (daily oceanographic and meteorological observations)	Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	

Gauge Status * = Operational / = Partial - = Non-Operational
 Data Collected * = All / = Partial - = None
 Visual Observations * = Complete / = Partial - = None

**Table 2
Gauge Locations**

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates		Gauge Depth NGVD, m	Water Depth NGVD, m
				Crossshore m	Longshore m		
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	-----	-----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface	-7.62

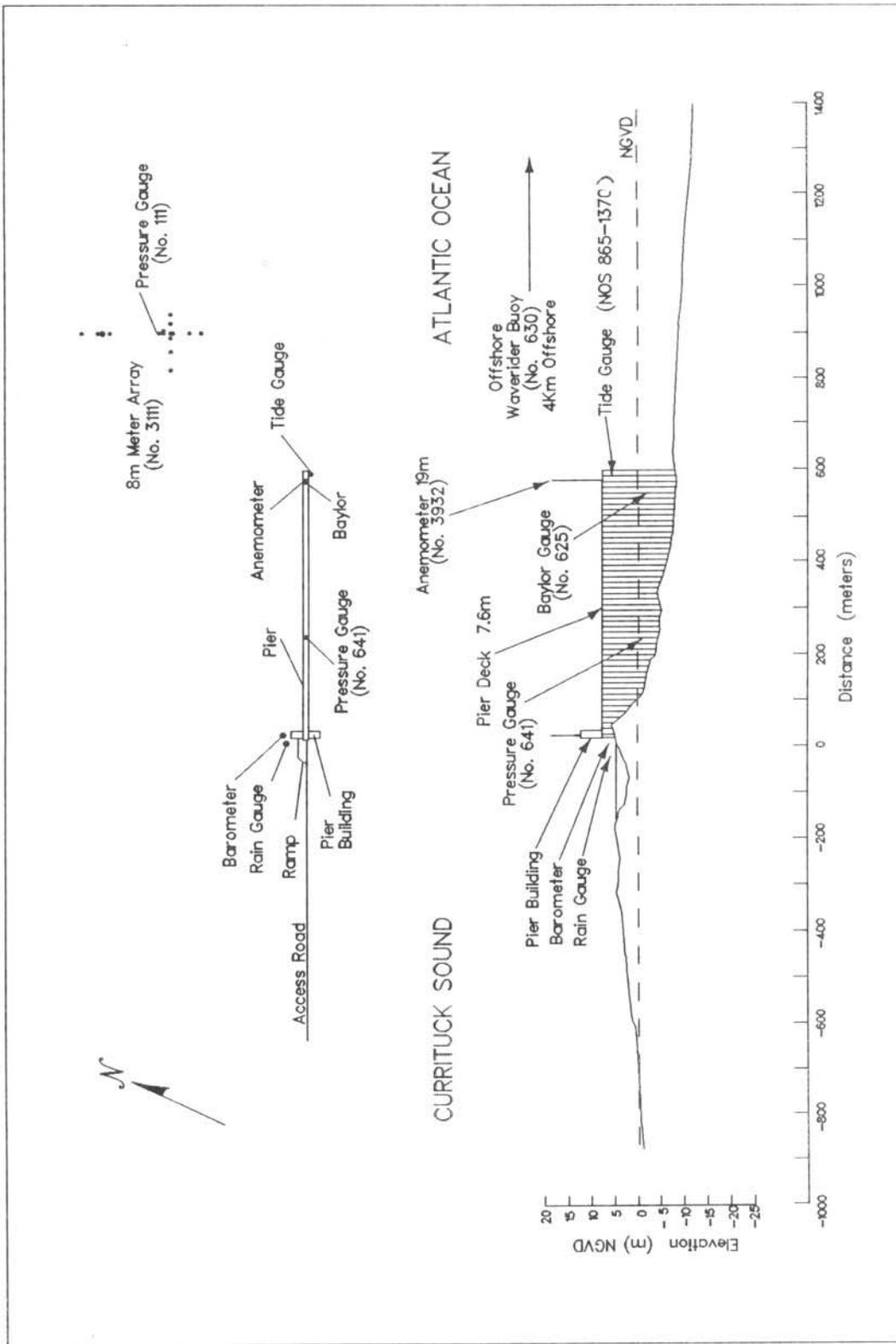


Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

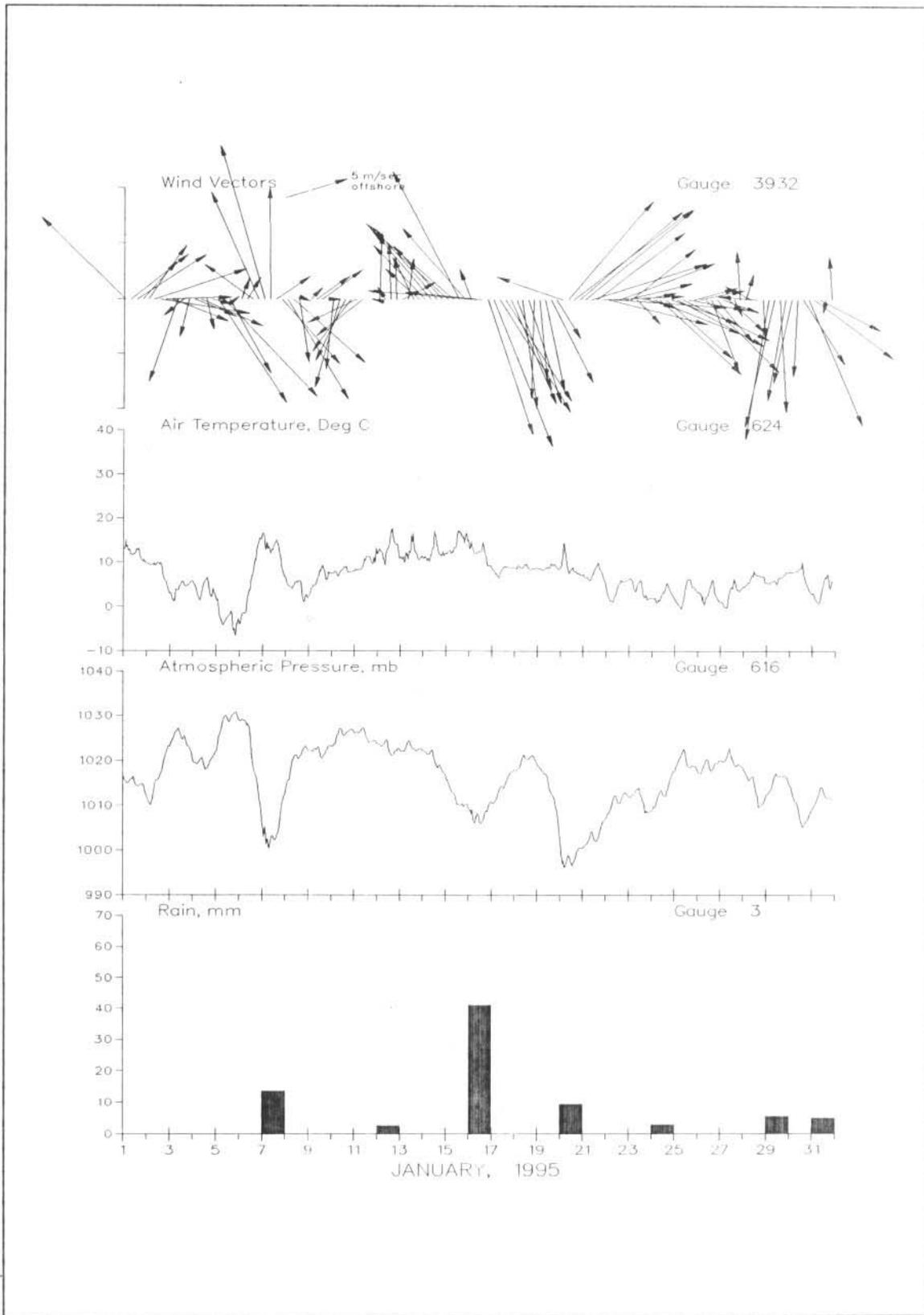


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Jan 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	10	138	12.9	1016.4	0
	700	6	227	12.3	1015.7	0
	1300	7	232	12.6	1014.7	0
	1900	4	217	10.4	1014.7	0
2	100	6	210	9.7	1011.4	0
	700	7	248	9.4	1012.3	0
	1300	7	281	9.7	1015.9	0
	1900	5	267	6.0	1020.5	0
3	100	5	295	3.0	1023.8	0
	700	8	15	3.8	1026.3	0
	1300	2	44	5.5	1024.7	0
	1900	4	11	4.9	1023.3	0
4	100	4	296	5.2	1019.7	0
	700	5	297	1.4	1020.0	0
	1300	3	348	6.0	1018.0	0
	1900	2	287	2.3	1020.2	0
5	100	11	331	1.7	1022.3	0
	700	11	321	-4.1	1028.5	0
	1300	7	335	-2.0	1028.8	0
	1900	0		-4.8	1030.5	0
6	100	2	197	-3.9	1028.9	0
	700	2	208	-1.3	1028.6	0
	1300	5	129	7.0	1022.0	0
	1900	10	159	13.9	1015.2	0
7	100	14	166	16.3	1004.6	0
	700	10	179	13.2	1000.4	13
	1300	3	231	14.4	1002.3	0
	1900	7	323	10.6	1007.6	0
8	100	10	332	5.8	1014.0	0
	700	8	316	4.0	1019.1	0
	1300	6	352	5.7	1020.5	0
	1900	0		1.0	1022.6	0
9	100	1	221	2.7	1022.1	0
	700	3	230	5.0	1022.7	0
	1300	4	229	8.4	1021.2	0
	1900	1	270	6.3	1022.2	0
10	100	6	5	7.4	1023.0	0
	700	8	12	6.9	1025.8	0
	1300	6	21	9.0	1025.6	0
	1900	6	31	7.8	1026.7	0

Table 3
Meteorological Data (continued)

Jan 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	4	59	8.4	1026.1	0
	700	5	46	8.6	1026.6	0
	1300	1	67	11.4	1025.5	0
	1900	0		9.7	1024.2	0
12	100	6	181	12.8	1023.7	0
	700	1	151	10.4	1023.6	2
	1300	5	177	14.9	1022.1	0
	1900	4	177	14.1	1022.2	0
13	100	3	238	10.9	1022.2	0
	700	4	186	12.0	1023.3	0
	1300	4	156	16.6	1022.7	0
	1900	4	135	10.6	1022.4	0
14	100	6	140	11.1	1022.2	0
	700	7	143	10.9	1021.5	0
	1300	8	142	16.2	1019.7	0
	1900	6	141	11.3	1018.6	0
15	100	8	135	11.9	1015.8	0
	700	10	134	12.3	1013.0	0
	1300	13	155	17.1	1010.3	0
	1900	8	142	14.4	1009.9	0
16	100	3	161	13.3	1009.1	0
	700	8	95	11.9	1006.1	41
	1300	6	96	12.4	1006.1	0
	1900	13	344	9.6	1009.0	0
17	100	14	341	8.4	1010.5	0
	700	12	331	6.6	1012.8	0
	1300	11	331	9.1	1013.9	0
	1900	10	339	9.0	1017.0	0
18	100	9	341	8.7	1017.6	0
	700	10	353	8.8	1019.1	0
	1300	10	344	9.2	1020.4	0
	1900	9	1	8.6	1021.2	0
19	100	7	355	8.7	1018.9	0
	700	8	349	8.4	1017.4	0
	1300	8	336	9.1	1013.7	0
	1900	4	332	9.2	1010.7	0
20	100	5	111	9.4	1000.5	0
	700	11	216	9.0	997.5	9
	1300	12	228	8.9	996.6	0
	1900	11	225	7.5	999.9	0

Table 3
Meteorological Data (concluded)

Jan 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	12	226	6.7	1000.6	0
	700	9	250	6.0	1002.6	0
	1300	9	228	8.8	1002.3	0
	1900	6	267	8.0	1004.8	0
22	100	8	286	3.3	1007.5	0
	700	9	274	1.1	1010.4	0
	1300	8	246	5.0	1010.7	0
	1900	5	254	5.7	1012.7	0
23	100	7	227	6.3	1011.9	0
	700	3	321	3.5	1013.0	0
	1300	3	257	5.9	1012.3	0
	1900	2	290	1.6	1008.9	0
24	100	7	295	1.9	1009.0	0
	700	9	317	1.7	1011.9	2
	1300	7	316	3.3	1012.2	0
	1900	6	293	3.7	1015.5	0
25	100	8	302	1.5	1017.8	0
	700	8	299	-0.4	1021.0	0
	1300	5	282	5.8	1019.8	0
	1900	3	252	4.4	1018.9	0
26	100	4	256	3.5	1017.5	0
	700	9	319	0.5	1019.0	0
	1300	7	342	4.3	1018.5	0
	1900	5	325	2.5	1019.4	0
27	100	3	293	1.0	1020.0	0
	700	4	317	0.1	1020.7	0
	1300	2	338	5.1	1020.2	0
	1900	4	176	3.6	1019.3	0
28	100	2	194	4.5	1017.7	0
	700	2	120	6.0	1015.7	0
	1300	3	95	7.2	1013.4	0
	1900	4	356	7.0	1010.2	0
29	100	13	7	5.4	1012.6	0
	700	12	10	5.7	1014.9	5
	1300	10	357	6.7	1016.5	0
	1900	9	8	7.4	1016.7	0
30	100	8	10	7.9	1014.5	0
	700	7	2	8.0	1010.8	0
	1300	7	331	10.1	1005.9	0
	1900	12	340	4.6	1006.8	0
31	100	8	311	3.1	1009.2	0
	700	5	302	0.7	1012.2	4
	1300	1	10	6.6	1012.6	0
	1900	4	176	4.5	1011.8	0
		Resultant		Mean	Mean	Total
		2	306	7.1	1016.1	76

3 Wave Data

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4
Wave Data**

Jan 1995										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.74	5.7	1.07	11.7	1.21	12.0	82	1.19	5.9
	0700	1.16	7.8	1.16	8.1	1.26	8.2	76	1.49	7.0
	1300	0.66	8.6	0.82	8.3	0.92	8.9	76	0.99	8.6
	1900	0.68	8.3	0.74	8.3	0.76	8.2	110	0.83	8.1
2	0100	0.37	8.1	0.47	16.0	0.61	15.7	78	0.66	8.1
	0700	0.40	7.4	0.45	17.1	0.52	15.7	68	0.59	7.4
	1300	0.34	3.5	0.51	16.0	0.56	15.7	68	0.60	16.0
	1900	0.45	4.2	0.69	16.0	0.72	5.9	26	0.87	5.9
3	0100	0.40	3.5	0.69	4.2	0.73	5.3	28	0.96	5.6
	0700	0.45	3.9	0.72	3.7	0.74	3.9	20	0.83	5.3
	1300	0.35	3.8	0.69	5.6	0.72	5.9	44	0.81	5.3
	1900	0.33	4.2	0.67	5.5	0.65	5.6	44	0.79	5.4
4	0100	0.22	6.8	0.47	7.2	0.46	8.2	72	0.54	7.0
	0700	0.27	3.5	0.49	7.6	0.43	15.7	80	0.58	3.2
	1300	0.21	3.7	0.37	16.0	0.36	10.8	70	0.43	7.6
	1900	0.18	3.8	0.32	9.5	0.36	9.8	62	0.42	9.5
5	0100	0.45	3.9	0.69	4.1	0.95	4.8	32	0.99	3.9
	0700	0.77	5.1	1.28	7.0	1.39	6.6	46	1.77	6.6
	1300	0.73	4.9	1.21	6.8	1.16	7.1	50	1.55	6.6
	1900	0.33	4.1	0.77	6.5	0.78	5.9	42	0.97	7.6
6	0100	0.19	5.1	0.52	7.6	0.50	7.6	58	0.62	7.0
	0700	0.13	5.1	0.31	7.0	0.33	6.2	60	0.39	5.9
	1300	0.13	5.6	0.26	8.3	0.28	8.2	80	0.31	8.3
	1900	0.27	3.1	0.45	3.0	0.65	5.9	118	0.57	3.1
7	0100	1.13	8.1	1.19	7.8	1.37	8.9	90	1.57	7.6
	0700	0.99	10.3	1.15	10.3	1.12	10.8	90	1.43	10.7
	1300	0.94	11.2	1.00	11.2	0.97	10.8	90	1.23	11.2
	1900	0.67	11.2	0.91	11.2	0.97	10.8	112	1.00	11.2
8	0100	0.93	5.3	1.30	5.6	1.43	5.6	28	1.63	6.3
	0700	0.58	4.7	1.13	5.9	1.27	5.9	26	1.40	5.6
	1300	0.60	9.9	1.03	5.4	1.07	9.8	106	1.24	6.0
	1900	0.37	9.5	0.89	7.0	0.92	7.1	60	1.00	7.0
9	0100	0.31	8.6	0.70	7.2	0.78	6.6	58	0.87	6.5
	0700	0.20	7.8	0.58	6.6	0.62	6.6	60	0.68	6.5
	1300	0.26	8.6	0.53	10.7	0.60	9.8	80	0.63	11.7
	1900	0.21	8.1	0.50	8.9	0.58	10.8	86	0.56	11.2
10	0100	0.27	8.1	0.51	9.9	0.55	8.9	84	0.61	10.7
	0700	0.43	3.8	0.93	4.2	0.92	4.8	60	1.10	4.6
	1300	0.42	4.3	0.92	4.9	0.89	5.3	44	1.10	5.3
	1900	0.31	3.4	0.79	5.1	0.76	5.3	28	0.91	5.4

Table 4
Wave Data (continued)

Jan 1995										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.36	4.2	0.75	6.6	0.76	5.6	24	0.83	5.0
	0700	0.29	11.2	0.60	11.7	0.65	12.0	66	0.71	11.2
	1300	0.31	10.2	0.64	11.1	0.63	10.7	0	0.77	11.6
12	1900	0.32	11.2	0.58	10.7	0.60	10.8	86	0.65	10.7
	0100	0.54	5.3	0.76	5.3	0.77	5.6	90	0.97	5.4
	0700	0.68	6.3	0.85	6.5	0.92	6.6	80	1.06	6.3
13	1300	0.61	6.8	0.77	7.2	0.83	7.1	108	0.94	7.0
	1900	0.66	7.2	0.80	7.8	0.85	7.6	108	0.99	7.2
	0100	0.62	7.2	0.87	10.7	0.95	9.8	86	1.06	7.0
14	0700	0.68	7.0	0.91	11.2	0.95	10.8	84	1.02	6.3
	1300	0.63	7.0	0.79	11.2	0.90	10.8	84	1.02	10.7
	1900	0.73	7.0	0.87	7.2	0.96	10.8	80	1.11	7.4
15	0100	0.70	7.0	0.83	7.4	0.97	10.8	80	1.13	7.0
	0700	0.90	7.0	1.05	7.6	1.17	7.6	116	1.33	7.6
	1300	0.95	8.6	1.34	8.3	1.38	8.2	76	1.59	8.3
16	1900	1.18	8.9	1.48	9.2	1.49	8.9	108	1.66	8.9
	0100	1.14	9.2	1.66	9.5	1.89	8.9	88	2.00	9.5
	0700	1.50	10.3	2.13	10.3	2.18	10.8	110	2.48	10.3
17	1300	1.13	11.7	2.57	11.2	2.78	10.8	84	3.11	11.2
	1900	1.39	11.7	2.34	11.7	2.87	12.0	106	2.63	11.7
	0100	1.05	12.9	1.99	12.2	2.18	12.0	106	2.57	11.2
18	0700	1.48	10.7	1.68	11.2	1.88	10.8	106	2.00	10.7
	1300	0.97	10.7	1.65	11.2	1.78	10.8	84	1.79	10.7
	1900	1.36	11.2	1.58	11.2	1.89	10.8	112	1.89	10.3
19	0100	1.18	5.9	1.89	6.0	2.15	10.8	78	2.27	5.9
	0700	1.23	10.7	1.61	10.3	1.96	10.8	76	2.12	10.7
	1300	0.98	10.7	1.58	10.7	1.70	10.8	72	1.88	10.3
20	1900	1.01	10.3	1.47	10.3	1.68	10.8	106	1.88	10.3
	0100	0.84	5.5	1.37	10.3	1.55	9.8	76	1.78	10.3
	0700	0.96	10.3	1.57	9.9	1.63	9.8	86	1.81	9.9
18	1300	0.82	5.9	1.46	9.5	1.63	9.8	62	1.67	10.3
	1900	0.99	9.9	1.68	8.9	1.84	9.8	90	2.01	9.5
	0100	0.90	9.5	1.62	9.5	1.75	9.8	60	1.90	9.9
19	0700	1.01	9.5	1.55	9.5	1.80	9.8	78	1.99	9.5
	1300	1.02	10.7	1.51	10.7	1.58	9.8	82	1.65	10.3
	1900	1.11	10.3	1.43	10.3	1.64	10.8	84	1.79	10.3
20	0100	0.97	11.7	1.50	10.7	1.60	10.8	82	1.53	10.3
	0700	1.03	11.2	1.27	10.7	1.47	10.8	76	1.59	10.7
	1300	0.63	12.2	0.87	11.7	0.84	12.0	92	1.16	11.2
1900	0.52	10.7	0.59	10.7	0.65	10.8	88	0.82	10.3	

Table 4
Wave Data (concluded)

Jan 1995										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	0.35	10.3	0.43	11.2	0.47	10.8	94	0.67	10.7
	0700	0.26	10.3	0.35	16.0	0.41	10.8	70	0.60	10.3
	1300	0.25	17.1	0.40	10.7	0.40	15.7	58	0.51	10.7
	1900	0.26	17.1	0.41	16.0	0.42	15.7	72	0.49	10.7
22	0100	0.30	17.1	0.49	16.0	0.47	15.7	80	0.59	10.7
	0700	0.28	17.1	0.51	16.0	0.53	15.7	68	0.70	4.0
	1300	0.30	17.1	0.50	16.0	0.46	15.7	76	0.62	16.0
	1900	0.21	17.1	0.39	17.1	0.43	15.7	58	0.47	16.0
23	0100	0.28	17.1	0.42	17.1	0.39	18.5	74	0.45	17.1
	0700	0.26	18.3	0.44	17.1	0.40	15.7	68	0.49	17.1
	1300	0.28	18.3	0.44	16.0	0.54	18.5	74	0.51	17.1
	1900	0.24	16.0	0.46	16.0	0.52	15.7	80	0.58	5.1
24	0100	0.30	17.1	0.52	17.1	0.65	4.4	28	0.90	4.4
	0700	0.41	4.7	0.78	4.7	0.96	5.6	46	1.19	5.0
	1300	0.49	5.6	0.83	5.6	0.84	5.6	38	1.21	5.4
	1900	0.49	5.4	0.81	5.6	0.90	5.6	38	1.04	5.6
25	0100	0.66	6.3	0.98	6.1	1.08	6.2	40	1.33	6.6
	0700	0.55	6.6	0.96	6.6	1.02	6.6	48	1.21	6.3
	1300	0.47	6.0	0.80	6.8	0.88	6.2	44	0.98	6.0
	1900	0.30	6.5	0.69	10.3	0.71	9.8	86	0.76	10.3
26	0100	0.27	9.5	0.47	9.9	0.54	9.8	82	0.55	8.9
	0700	0.45	4.2	0.80	4.1	0.93	9.8	84	0.99	4.3
	1300	0.56	5.9	0.96	6.0	1.01	5.9	42	1.13	6.5
	1900	0.44	6.5	0.79	6.1	0.80	6.2	46	0.98	6.3
27	0100	0.36	5.3	0.64	5.5	0.65	5.3	34	0.74	6.0
	0700	0.33	5.7	0.62	5.6	0.63	5.9	40	0.75	5.7
	1300	0.40	5.7	0.70	5.6	0.74	5.9	44	1.00	6.0
	1900	0.22	5.4	0.45	9.9	0.47	9.8	76	0.57	5.4
28	0100	0.17	14.3	0.34	9.5	0.36	9.8	84	0.42	5.0
	0700	0.17	9.5	0.29	12.2	0.29	10.8	98	0.31	10.3
	1300	0.13	6.6	0.26	12.9	0.29	13.6	80	0.31	13.5
	1900	0.29	4.5	0.57	4.6	0.53	4.8	46	0.63	4.5
29	0100	1.08	7.4	2.00	7.0	2.22	7.1	52	2.39	7.0
	0700	1.16	7.4	1.79	7.4	1.83	7.1	52	2.07	7.4
	1300	0.82	6.8	1.43	6.6	1.55	6.6	58	1.71	7.0
	1900	0.92	7.4	1.52	7.4	1.63	7.1	54	1.75	7.2
30	0100	0.76	6.5	1.31	7.4	1.44	7.1	62	1.52	6.6
	0700	0.86	6.8	1.53	7.8	1.62	7.1	58	1.80	7.4
	1300	0.84	7.2	1.41	7.2	1.51	7.6	62	1.63	7.8
	1900	0.93	6.1	1.58	8.1	1.79	8.2	58	1.89	8.1
31	0100	0.93	7.0	1.71	7.8	1.76	8.2	58	2.01	8.6
	0700	0.72	8.9	1.32	8.3	1.38	8.9	66	1.58	8.9
	1300	0.84	11.2	1.27	10.7	1.32	10.8	84	1.38	11.2
	1900	0.42	11.7	0.87	10.3	0.95	10.8	82	1.15	10.3
Mean		0.61	8.4	0.96	9.3	1.03	9.4	70	1.16	8.4
Std dev		0.34	3.7	0.49	3.5	0.55	3.2	23	0.58	2.9

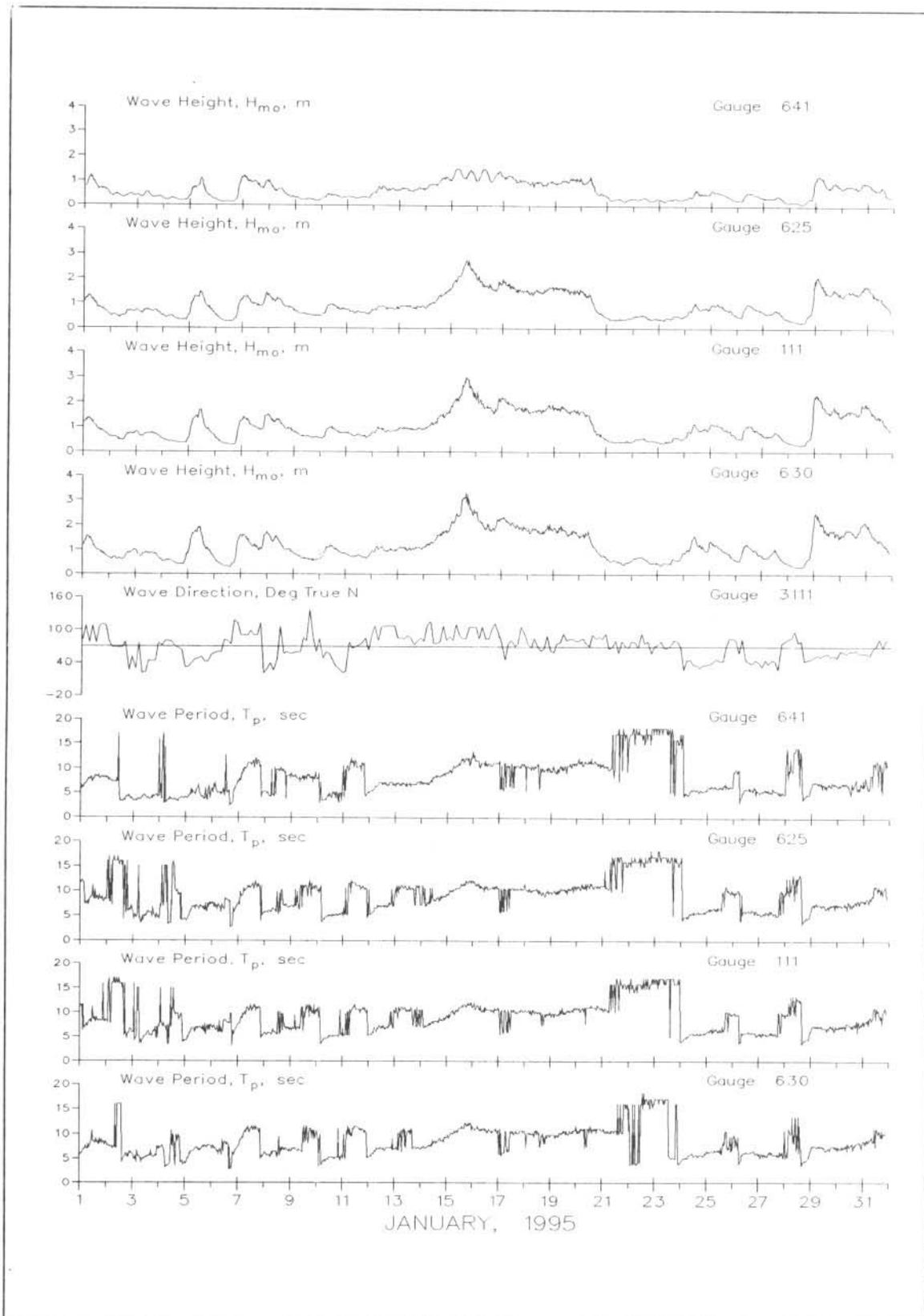


Figure 5. Wave Heights and Periods

4 Current Data

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

JANUARY 1995																	
Cross Long				Cross Long				Cross Long									
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100					1300						22	100	4	4	6	205
	700					1900							700	1	1	1	200
	1300					12	100						1300	1	-1	2	303
	1900						700						1900	1	0	1	261
2	100						1300					23	100	2	4	5	184
	700						1900						700	1	2	2	179
	1300						1300						1300	1	1	1	204
	1900						700						1900	0	4	4	155
						13	100					24	100	0	2	2	145
3	100						1300	2	3	3	194		700	-3	1	4	87
	700						1900	2	1	3	220		1300	0	-9	10	345
	1300					14	100	4	6	7	191		1900	0	-12	13	346
	1900						700	4	3	5	211	25	100	0	-13	14	345
							1300	6	7	9	199		700	-6	-17	19	360
4	100						1900	0	0	0			1300	-2	-16	18	351
	700					15	100	3	7	8	180		1900	-3	-12	14	359
	1300						700	6	8	10	195	26	100	-1	5	5	144
	1900						1300	2	18	19	167		700	-6	0	7	62
5	100						1900	2	10	10	174		1300	1	-14	15	336
	700					16	100	5	7	8	196		1900	1	-7	8	337
	1300						700	-3	12	12	141	27	100	2	6	6	180
	1900						1300	2	7	7	176		700	-4	-6	9	16
6	100						1900	-2	4	5	125		1300	2	0	2	245
	700					17	100	0	-33	34	342		1900	5	-2	6	275
	1300						700	-1	-27	29	343	28	100	3	7	8	182
	1900						1300	0	-25	26	339		700	3	6	6	187
7	100						1900	-3	-30	31	347		1300	2	4	4	184
	700					18	100	-1	-27	28	343		1900	0	-6	7	343
	1300						700	-1	-22	23	344	29	100	-4	-27	28	349
	1900						1300	-1	-37	38	342		700	-2	-29	30	346
8	100						1900	0	-28	29	340		1300	-4	-29	30	350
	700					19	100	1	-26	27	339		1900	-1	-31	32	343
	1300						700	0	-20	21	339	30	100	-2	-27	28	345
	1900						1300	3	-5	7	317		700	0	-12	13	339
9	100						1900	6	-1	6	265		1300	0	-12	13	340
	700					20	100	-2	-13	15	353		1900	3	-11	12	327
	1300						700	10	0	10	249	31	100	1	-38	39	338
	1900						1300	9	11	14	201		700	-6	8	11	115
10	100						1900	6	19	19	176		1300	1	-1	2	319
	700					21	100	0	19	19	161		1900	5	0	5	251
	1300						700	2	21	21	165						
	1900						1300	4	7	8	191						
11	100						1900	4	7	8	188						
	700																

KEY:
 +cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Jan 1995												
Pier End					Mid-Surf Zone				Beach			
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	11	-11	16	25	5	-30	31	349	North	9	S	
2	3	12	13	146	0	0	0		North	3	S	
3	-12	29	31	182	8	30	31	146	North	13	S	
4	4	7	8	129	0	23	23	160	North	5	S	
5	-16	41	44	182	-26	87	91	177	North	12	S	
6	1	-25	25	343	7	-14	15	7	South	15	N	
7	18	-32	37	9	10	-38	39	354	South	43	N	
8	0	41	41	160	0	68	68	160	North	8	S	
9	1	-11	11	346	3	-29	29	346	North	11	S	
10	-12	30	33	182	0	55	55	160	North	24	S	
11	0	17	17	160	-4	19	19	171	North	6	S	
12	-3	10	11	177	0	-55	55	340	South	30	N	
13	0	-17	17	340	0	-47	47	340	South	27	N	
14	0	-30	30	340	11	-76	77	349	South	23	N	
15	0	-68	68	340	0	-102	102	340	South	23	N	
16	-5	-47	47	334	0	-87	87	340	South	18	S	
17	0	76	76	160	0	76	76	160	North	46	S	
18	-9	87	88	166	0	61	61	160	North	40	S	
19	10	51	52	149	17	55	58	143	North	30	S	
20	25	-21	33	30	0	-55	55	340	South	43	N	
21	13	13	18	70	1	-5	5	349	South	0		
22	6	21	22	143	11	23	26	136	North	11	S	
23	6	6	8	70	0	4	4	160	North	3	S	
24	10	34	35	143	10	51	52	149	North	49	S	
25	7	36	37	149	0	68	68	160	North	26	S	
26	0	38	38	160	10	32	33	143	North	37	S	
27	0	29	29	160	4	25	26	151	North	24	S	
28	3	-22	22	349	-1	-10	10	331	South	0		
29	0	76	76	160	0	122	122	160	North	36	S	
30	0	41	41	160	-9	44	44	171	North	30	S	
31	6	38	39	151	11	76	77	151	no observation			

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Jan 1995

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0915	105			116	9.4	1.0232	0.6
2	0835	80			18	9.4	1.0262	0.6
3	0745	45			24	8.9	1.0258	0.6
4	0755	15			10	8.9	1.0260	1.8
5	0745	45			125	7.2	1.0252	0.3
6	0825	45	110		15	6.7	1.0250	1.5
7	1010	100			70	8.9	1.0260	0.6
8	0941	50			55	8.9	1.0262	0.6
9	0830	65			18	8.9	1.0260	1.2
10	0801	55			98	8.3	1.0242	0.9
11	0920	40	90		22	8.1	1.0242	1.8
12	0753	105			27	8.6	1.0241	0.9
13	0734	90	110		24	8.9	1.0249	1.8
14	0905	95			94	9.4	1.0252	0.9
15	1103	100			357	10.0	1.0260	0.3
16	1020	90		90	424	11.1	1.0260	0.6
17	0855	35	10	40	174	10.0	1.0264	0.6
18	0923	60	40		140	9.4	1.0248	0.6
19	0755	55	40	55	151	8.9	1.0232	0.6
20	0805	95	110	85	81	8.9	1.0242	0.6
21	0915	85			5	8.9	1.0258	0.6
22	1010	10			6	8.3	1.0258	0.9
23	0800	0			8	8.3	1.0258	1.2
24	0810	50	10		98	7.5	1.0248	0.9
25	0918	40			99	6.9	1.0244	0.6
26	0710	30	55		10	6.7	1.0228	1.2
27	0750	25	60		9	6.1	1.0226	1.5
28	0740	50			5	6.7	1.0226	2.7
29	0921	55	30		174	6.9	1.0230	0.3
30	0740	75	50		134	6.7	1.0224	0.6
31	0720	50	65		130	6.7	1.0230	0.6

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

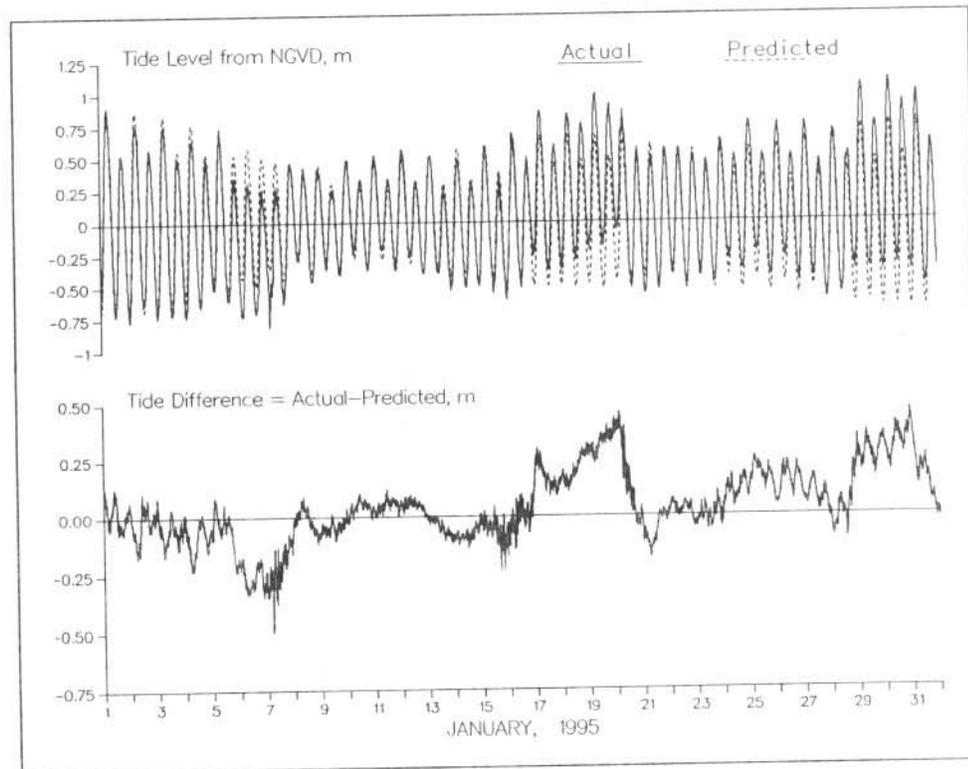


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

JAN 1995 Tide Levels															
High			Low			Mean	Range	High			Low		Mean	Range	
Day	Time	m	Day	Time	m	m	m	Day	Time	m	Day	Time	m	m	m
1	0654	0.91	1	0018	-0.60	0.25	1.50	16	1930	0.50	16	1336	-0.52	0.00	1.02
1	1924	0.54	1	1318	-0.72	-0.07	1.26	17	0700	0.86	17	0036	-0.27	0.28	1.12
2	0812	0.76	2	0118	-0.77	0.03	1.53	17	2006	0.59	17	1348	-0.38	0.11	0.98
2	1948	0.57	2	1348	-0.65	-0.04	1.22	18	0806	0.83	18	0200	-0.38	0.25	1.21
3	0848	0.75	3	0154	-0.75	0.02	1.50	18	2030	0.76	18	1418	-0.30	0.24	1.07
3	2006	0.51	3	1500	-0.72	-0.10	1.23	19	0912	0.99	19	0224	-0.24	0.38	1.23
4	0948	0.64	4	0318	-0.74	-0.05	1.38	19	2142	0.91	19	1454	-0.20	0.35	1.11
4	2200	0.49	4	1530	-0.66	-0.09	1.15	20	0912	0.86	20	0236	-0.07	0.34	0.93
5	0954	0.74	5	0418	-0.53	0.06	1.26	20	2154	0.56	20	1600	-0.51	-0.01	1.08
5	2236	0.35	5	1600	-0.61	-0.15	0.96	21	0942	0.50	21	0348	-0.57	-0.04	1.07
6	1100	0.31	6	0500	-0.74	-0.22	1.04	21	2300	0.56	21	1618	-0.54	0.02	1.10
6	2318	0.26	6	1700	-0.71	-0.26	0.97	22	1042	0.56	22	0418	-0.41	0.07	0.97
7	1112	0.28	7	0448	-0.82	-0.20	1.10	22	2330	0.51	22	1718	-0.51	0.00	1.02
8	0012	0.46	7	1730	-0.64	-0.06	1.10	23	1054	0.45	23	0542	-0.44	0.01	0.89
8	1212	0.43	8	0700	-0.26	0.05	0.69	24	0024	0.63	23	1806	-0.49	0.06	1.12
9	0054	0.41	8	1812	-0.47	-0.03	0.88	24	1236	0.50	24	0718	-0.30	0.09	0.81
9	1336	0.24	9	0742	-0.37	-0.04	0.61	25	0130	0.77	24	1930	-0.38	0.18	1.15
10	0300	0.49	9	2018	-0.42	0.03	0.90	25	1400	0.51	25	0754	-0.25	0.14	0.76
10	1436	0.33	10	0824	-0.25	0.05	0.58	26	0324	0.76	25	2030	-0.44	0.15	1.20
11	0306	0.52	10	2054	-0.37	0.08	0.89	26	1512	0.50	26	0918	-0.29	0.11	0.80
11	1524	0.33	11	0906	-0.22	0.05	0.56	27	0348	0.76	26	2118	-0.47	0.14	1.23
12	0354	0.56	11	2106	-0.37	0.11	0.93	27	1630	0.47	27	1018	-0.45	0.01	0.91
12	1606	0.32	12	1030	-0.28	0.02	0.60	28	0530	0.68	27	2142	-0.62	0.03	1.29
13	0448	0.51	12	2236	-0.41	0.05	0.92	28	1748	0.52	28	1124	-0.57	-0.02	1.10
13	1706	0.25	13	1042	-0.40	-0.10	0.65	29	0554	1.05	28	2342	-0.39	0.30	1.44
14	0548	0.48	13	2248	-0.54	-0.03	1.02	29	1812	0.76	29	1300	-0.38	0.19	1.14
14	1754	0.31	14	1206	-0.52	-0.11	0.83	30	0624	1.09	30	0012	-0.40	0.33	1.49
15	0636	0.58	15	0018	-0.50	0.03	1.09	30	1900	0.92	30	1248	-0.36	0.29	1.28
15	1842	0.38	15	1242	-0.57	-0.12	0.95	31	0718	1.00	31	0112	-0.40	0.29	1.39
16	0612	0.69	16	0030	-0.62	0.04	1.30	31	1936	0.62	31	1324	-0.52	0.05	1.13

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in December 1994 and the survey(s) in January 1995 on profile line 188, located 517 m south of the pier.

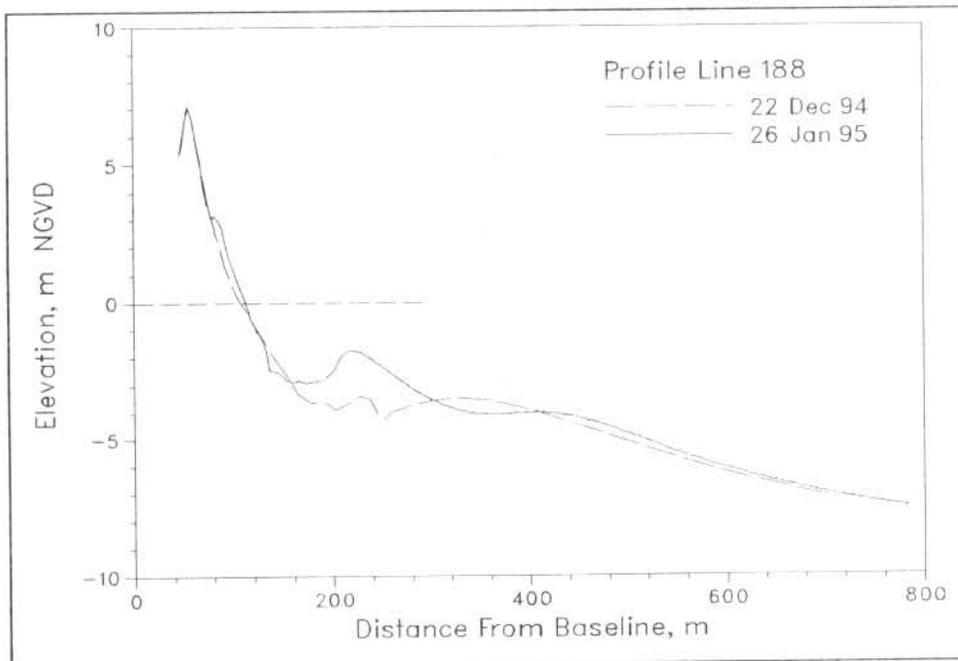


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1995. Cross-hatched areas indicate changes to the annual envelope which occurred in January.

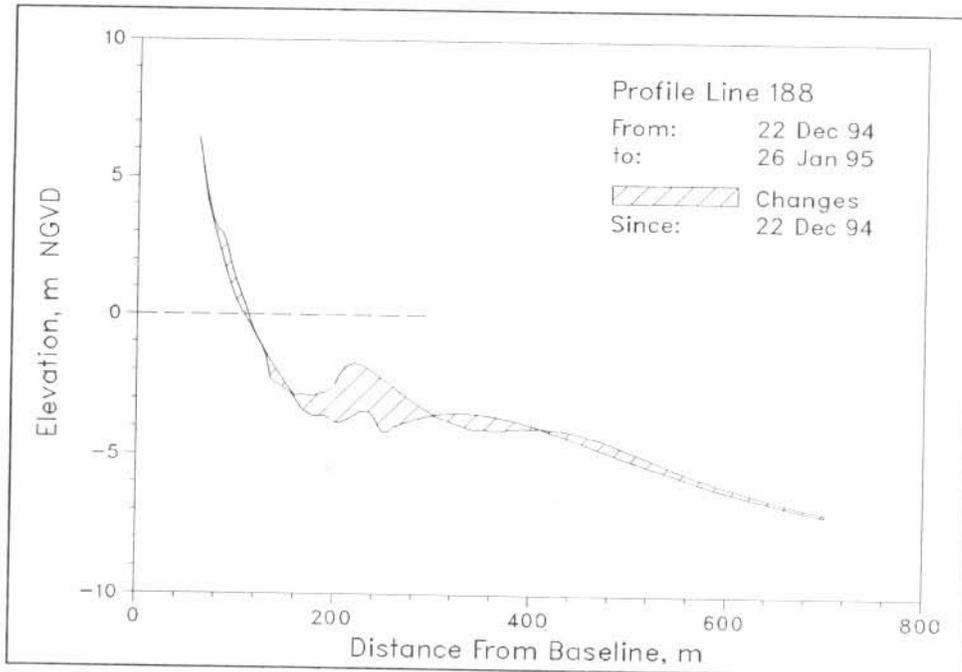


Figure 8. Profile Envelope - Profile Line 188.

B. **Bathymetry.** Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 25 January. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

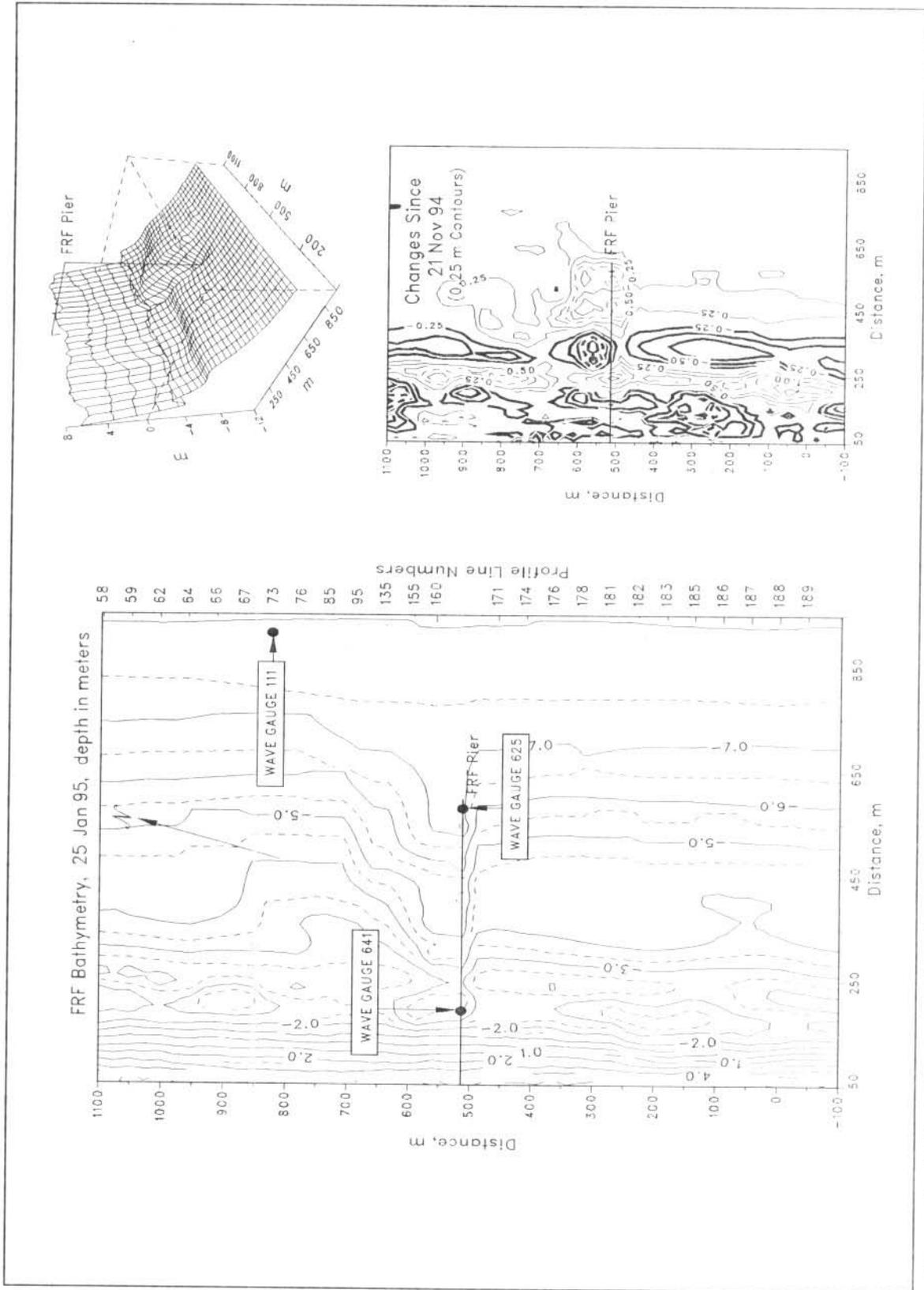


Figure 9. FRF Bathymetry, Depths Relative to NGVD

8 Special Events

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
15 Jan (0434)	16 Jan (0242)
28 Jan (2342)	29 Jan (0400)

B. Storm Synopsis.

15-16 Jan Winds (SE) associated with a high pressure cold front reached a maximum of 15 m/s at 1216 EST on 15 January. The maximum H_{mo} at gauge 630, reached 3.2 m ($T_p=11.1$ s) at 1634 EST on 15 January. There was 41 mm of precipitation.

28-29 Jan Northeasterly winds were funneled between a Canadian high pressure system and a low pressure that approached from the west. Winds intensified as the low pressure system moved over the North Carolina coast and began moving out to sea by the morning of 29 January. Maximum onshore winds (NE) reached 13 m/s at 0208 EST on 29 January. The maximum H_{mo} at gauge 625, reached 2.1 m ($T_p=7.3$ s) at 0208 EST on 29 January. There was 5 mm of precipitation.

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge	U.S. Geological Survey
USACE-OCE	U.S. Library of Congress
USACE-SAD	U.S. National Park Service
USACE-NAP	U.S. National Weather Service
USACE-SAW	U.S. Naval Academy
USACE-WES	U.S. Naval Civil Eng. Lab
NAVSAC	U.S. Naval Oceanographic Off.
NOAA/NOS/OMS	U.S. Naval Research Lab
National Marine Fisheries	

Colleges/Universities:

Bucknell University	Scripps Institution of Oceanography
California Inst. of Tech.	Stockton State College
Duke Marine Lab	University Calif-Berkeley
East Carolina University	University of Florida
Florida Inst. of Tech.	University of Maryland-College Park
M.I.T.	University of Maryland-Baltimore
Naval Post Graduate School	University of North Carolina
NC State University	University of N C-Seagrant Program
Old Dominion University	University of Virginia
Oregon State University	Va. Inst. of Marine Science
Prince George's College	Rutgers University

Others:

Allied Signal Aerospace Co.	WCTI-TV
Applied Physics Lab	MEC Systems Corporation
Cape Hatteras Nat. Seashore	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	N.C. Div. Coastal Management
Coastal Science & Eng., Inc.	Oregon Inlet & Waterways Commis.
Dr. Cy Galvin	Raleigh-Durham Airport
GEOMET Tech., Inc.	Mr. Rowland
Mr. Hodges	Mr. Savage
Dr. Hylton	Science Application Int'l. Corp
Mr. Mason	Sherwood Industries
Mr. Rodgers	SEASUN Power Systems

Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)